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Status of the Atlantic salmon, Salmo salar, Population of Conne River, Newfoundland, 1988

by

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Abstract

Results obtained from a fish counting fence provided the basis for the assessment of the Atlantic salmon population of Conne River, Newfoundland, SFA 11, in 1988. Returns to the river were 7121 salmon $<$63 cm in size and 418 salmon $\geq$63 cm in size. This represents a decrease of 26 % from the total number of fish counted in 1987 and is 5% lower than the count in 1986. Total egg deposition from small salmon in 1988 was estimated to be 9.97×10^6 eggs which is 28% higher than the target egg requirement of 7.8×10^6 eggs. This is equivalent to a surplus of 1134 fish$<$63 cm in size. An additional 1.68×10^6 eggs were estimated to have been deposited by large salmon (about 878 fish) and are considered as a buffer to the target egg deposition requirement. The recreational catch of 1544 salmon was three percent lower than in 1987 while the native food fishery reported a catch of 609 salmon. A mark-recapture experiment indicated an output of 60,000-66,000 smolts in 1988. With survival back to the river estimated at 10.3%, 6180-6798 salmon are expected to return to the Conne River in 1989 with an available harvest of 2180-2789 salmon.

Résumé

Les résultats obtenus à un barrage de dénombrement du poisson ont servi de base à l'évaluation de la population de saumon de l'Atlantique de la rivière Conne, zone de pêche du saumon 11, à Terre-Neuve en 1988. Les montaisons dans la rivière se sont établies à 7 121 saumons de moins de 63 cm et 418 saumons de 63 cm ou plus. Ce chiffre représente une diminution de 26 % et de 5 % respectivement par rapport au nombre total de poissons recensé en 1987 et en 1986. On estime que les petits saumons ont déposé $9,97 \times 10^6$ oeufs en 1988, soit 28 % de plus que le nombre-cible requis ($7,8 \times 10^6$). Cela équivaut à un surplus de 1 134 poissons de moins de 63 cm. On estime, par ailleurs, que les gros saumons ont déposé $1,68 \times 10^6$ oeufs (environ 878 poissons), qui constituent une marge d'appoint par rapport au nombre-cible. Les prises sportives, soit 1 544 saumons, ont été inférieures de trois pour cent à celles de 1987, tandis que la pêche de subsistance des autochtones s'est soldée par la capture de 609 saumons. Selon une expérience de marquage-recapture, le nombre de saumonneaux aurait été de 60 000 à 66 000 en 1988. Le taux de survie jusqu'à la montaison étant environ de 10,3 %, de 6 180 à 6 798 saumons devraient revenir dans la rivière Conne en 1989, offrant une récolte de 2 180 à 2 798 saumons.

Introduction

A fish counting fence was operated on the Conne River, Newfoundland (Fig. 1), SFA 11, during 1988 to enumerate and provide the basis for an assessment of the Atlantic salmon population. This marked the third year of operation of this facility. Similar to the situation in past years, Atlantic salmon stocks of the Conne River contributed to commercial, recreational, and native food fisheries in 1988. The opening and closing dates for these fisheries are summarized in Table 1. The restrictions for the food fishery were essentially the same as in past years with a quota of 1200 salmon <63 cm in length with a maximum allowable retention of 200 fish per week. This was later modified to allow a total of 350 fish per week. Both recreational and food fisheries were prohibited from retaining salmon ≥63 cm. However, dead salmon of this size in the native food fishery could be retained and counted against their quota.

The objective of this paper is to present an assessment of the Atlantic salmon population in the Conne River for 1988. Catch data from various fisheries are reviewed, salmon returns to the Conne River are presented and compared to previous forecasts, biological characteristics of the population are summarized and compared among years, and a forecast of adult returns in 1989 is provided.

Methods

Landings

Data on landings in the recreational fisheries were collected by the Department of Fisheries and Oceans (DFO) Fisheries Officers. Landings in the native food fishery were obtained from the Conne River Native Band Council. Commercial landings for Statistical Section 36 were obtained from Fisheries Statistics and Systems Branch of DFO. Commercial catch information for 1988, however, was not available at the present time.

Total returns, biological characteristics and spawning escapement

Adult Atlantic salmon migrants were enumerated at a fish counting fence, located about 1 km upstream from the mouth of the Conne River (Fig. 1), which operated from May 21 to August 29, 1988. Total returns included the count of fish at the fence, plus known mortalities below the counting fence, in addition to the estimated number of Conne River origin salmon caught in the native food fishery. Since no estuarine tagging was carried out in 1988, an estimate of the proportion of Conne River origin salmon in the food fishery was derived using the average value calculated during the past two years. Total returns were compared to returns forecasted by a mark-recapture experiment on smolts carried out in 1987.

Biological characteristic information, including fork length, whole weight, age, and sex, were obtained from sampling salmon caught in the recreational fishery. Comparisons of the difference in run timing among years, and of the river age distribution of smolts and adults, were carried out using likelihood ratio statistics (G^2-test).

Number of spawners were estimated from:

Spawners = salmon released at fence - unrecorded mortalities - angling catch.

Unrecorded mortalities, which include natural mortality in the river prior to spawning and illegal removals, were assumed to be 5% of the upstream run, similar to previous assessments (Porter et al. 1986; Dempson et al. 1987).

Egg deposition - 1988

Egg deposition was calculated separately for salmon <63 cm and salmon ≥63 cm and then summed.

Egg deposition = spawners x %female x fecundity at mean length.

An estimate of fecundity was obtained from the following relationship derived in 1987 from ripe salmon (Dempson et al. 1987):

$$\text{fecundity} = 0.1988(\text{fork length})^{2.3942} \quad (r^2=0.48,\ P<0.001)$$

where length is the mean length of female salmon <63 cm in size sampled in 1988.

An estimate of the egg deposition from salmon ≥63 cm in size was obtained in a similar manner as previous assessments (Dempson et al. 1987). This involved using the length-fecundity relationship for salmon <63 cm in size but, since there were no large salmon samples available in 1988, also assuming the same size (69.5 cm) and sex ratio (83% female) as in 1987.

Target spawning requirements

In previous assessments (Porter et al. 1986; Dempson et al. 1987) a ratio of eggs per recruit was developed for the fluvial habitat of Conne River. This ratio was then applied to the population size estimated in that year to obtain an estimate of the total number of eggs required to seed the system. The technique assumed similar survival rates from egg to recruits for stream and lacustrine production. This method also resulted in annual changes to the estimated target egg deposition. Since last year, no additional information has been obtained to assess the production of salmon in the lake habitat of the Conne River system. Consequently, the target egg deposition requirement for 1988 was the same as that used in 1987 of 7.8 million eggs or approximately 4000 salmon <63 cm. As in past assessments, egg deposition from salmon ≥63 cm was considered as a buffer to estimates of spawning requirements.

Forecast of salmon returns in 1989

A mark-recapture study was carried out to estimate the smolt production in 1988. The experiment was similar to that carried out in 1987 which used two partial fish counting fences, located about 10 km apart (Fig. 1), to catch migrating smolt. Smolts were tagged at the upstream release site using numbered green Floy streamer tags. These tags, approximately 90 mm in length, were selected as in 1987 because they alloved for individual identification of fish, they were easily and quickly applied to smolts with minimum handling, and were readily observable in the recapture trap. Smolts were not anesthetized. Approximately 5% of the tagged smolts were measured for fork length before release.

After tagging, smolts were held in a cage in the river for approximately one hour before being released. In order to examine tag loss, tagging or handling mortality, two groups of smolts were kept in a holding box (1.5 m x 1.0 m x 0.5 m) in the river for 7-day periods. A total of 200 tagged smolts and 90 untagged smolts were observed over two separate occasions.

A maximum-likelihood estimate derived by Darroch (1961) for a two-sample stratified population was applied to estimate the smolt population as in 1987. Similar to 1987, an adjustment was made to the smolt estimate to account for the large number of parr which migrated downstream into the estuary and are believed to smoltify at a later time.

Results

Landings

Table 2 summarizes the commercial landings of small and large salmon from Statistical Section 36, 1974-87. Landings in 1987 of 7.7 t of small salmon and 8.5 t of large salmon were below (>25%) the previous five-year means (1982-86), but similar to the previous 10-year average. The proportion by weight of small salmon in the total catch has increased by 17% for the period 1984-87 (47% small) in comparison with 1979-83 (40% small). No data were available at the present time for 1988.

Landings in the recreational fishery and native food fishery are summarized in Table 3. The recreational catch of 1544 was 3% lower than in 1987 and 29% below the previous five-year catch of 2184 fish. The reported number of rod-days increased by 11% from 1987. The native food fishery reported a catch of 607 small salmon and 2 large salmon.

Total returns, biological characteristics and spawning escapement

There were 7121 salmon <63 cm and 418 (5.5%) salmon $\geq$63 cm counted at the fence on Conne River in 1988 (Table 4). Mortalities found in the river downstream from the fence are included in the total (three small salmon). This represents a decrease of 26% from the total number of fish counted in 1987 and is 5% lower than the count in 1986.

Mean water temperatures and water levels are also summarized by week in Table 4. Water levels are relative to a bench mark established in 1986. The

negative readings indicate water levels below the top of the bench mark pin from which readings were taken. In general, water levels in 1988 were the highest among the three years (seasonal average = 30.2 cm), while 1987 was the lowest (seasonal average = 8.5 cm). Weekly mean water temperatures appeared greater in 1987 than in the other two years (five consecutive weeks with mean temperatures above 20°C, with eight consecutive weeks where maximum water temperatures greater than 25°C were recorded), although seasonal averages were similar. The impact of the low water levels and warm temperatures has not been evaluated.

A comparison of the number of small salmon by week at the counting fence indicated that the overall distribution of the run differed significantly among the three years ($G^2 = 1972$, $P = 0.00$, data from weeks 22 and 23 were pooled as were weeks 31-36). High water levels in 1988 provided an opportunity for fish to move through the system rather than hold up in specific pools and may have contributed to the decrease in the recreational catch in 1988.

Based on studies carried out in 1986 and 1987, it was estimated that an average of 83% (weighted average of both years) of the fish caught in the estuarine native food fishery were of Conne River origin. Total returns of adult salmon to the Conne River in 1988 were:

$$\text{small salmon} = [7121 + 0.833(607)] = 7627$$

$$\text{large salmon} = [418 + 0.833(2)] = 420$$

for a combined total of 8047 fish. The predicted estimate of 1988 returns, based on the 1987 smolt mark-recapture estimate, was 7900-8800 small salmon: actual returns were about 8.7% below the median predicted value, or 3.5% below the lower limit of the forecast, and would indicate a survival of back to the river of 10.3% (7,627/74,000). It should be noted, however, that approximately 7% of the estimated number of smolts in 1987 were tagged and may have experienced a higher mortality than untagged smolts. If this was true, then the survival back to the river would be slightly higher than 10.3%.

Tables 5 and 6 summarize biological characteristic information for Conne River smolts and virgin grilse, respectively, for the years 1986-88. Likelihood-ratio statistics indicated significant differences in the river age distribution of smolts among years ($G^2 = 14.1$, $P = 0.01$, comparing smolt ages 2, 3, and 4 only [3 of 9 cells had expected values less than 5]), and in the river age distribution of grilse among years ($G^2 = 38.2$, $P = 0.00$, comparing smolt ages 2, 3, and 4 only). There was no significant difference in the river age distribution of smolts in 1986 compared with the river age distribution of grilse in 1987 ($G^2 = 1.79$, $P = 0.41$). The river age distribution of smolts in 1987, however, was significantly different than that of the 1988 grilse ($G^2 = 15.5$, $P = 0.00$). Mean smolt age of grilse has decreased from 3.38 years in 1986 to 3.19 years in 1988. In contrast, mean river age of smolts has increased from 3.25 years in 1986 to 3.38 years in 1988.

Estimated spawning escapement in 1988 is summarized in Table 7 and was estimated to be 5211 salmon <63 cm and 397 salmon ≥63 cm in size. This

represents a decrease by 29% in the escapement of small salmon and a decrease of 14% in large salmon in comparison with 1987.

Egg deposition

The mean fork length of female salmon <63 cm in size was 50.6 cm, which gives a mean fecundity of 2391 eggs per female. The percentage of females in the run was 80% (N = 261, N-females = 210). The estimated number of eggs deposited are as follows:

$$\text{salmon } <63 \text{ cm} = 5211 \times 2391 \times 0.80 = 9.97 \times 10^6$$

$$\text{salmon } \geq 63 \text{ cm} = 397 \times 5111 \times 0.83 = 1.68 \times 10^6$$

Total egg deposition = 11.65×10^6.

[Note the relationship between fork length and number of green eggs derived from fish sampled from the 1987 recreational catch was not statistically significant ($r^2 = 0.02$, $P = 0.08$, $N = 137$).]

Forecast of salmon returns in 1989

A total of 3234 smolts was tagged and released in 1988. Mean length of smolts released was 149 mm (115-190 mm, SD = 13.5 mm, N = 151). At the downstream recapture trap a total of 19,385 smolts was caught, including 1,037 tagged smolts. Figure 2 illustrates the number of migrating smolt caught by day at the downstream recapture site in relation to mean daily water temperature and discharge. Of the 200 tagged smolts held for seven days to examine tag loss, handling, and tagging mortality, only one died while none of the untagged smolts died during the same periods. The mortality rate in 1988 was lower than that in 1987 (5 of 221 died), thus the 1987 rate was considered more appropriate and therefore applied to the 1988 data.

The estimated number of smolts in 1988 was 60,360 (95% CL 57,219-63,500). An adjustment to account for smolts produced in the lower part of the river and estuary added an additional 2,724 smolts to the total for a final estimate of 63,084 (95% CL 59,943-66,224). This is approximately 14% lower than the 1987 estimate. It is possible that some smolts could have been missed at the beginning of the run in 1988. High water levels prevented the partial fences from being installed earlier than May 9 (installed and fishing April 26 in 1987) and some smolts were caught on the first day of operation. Water temperatures, however, were cold during the first few days in May with mean temperatures below 8°C up until May 8. As was the case in 1987, substantial numbers of smolts were not caught until mean daily water temperatures reached 10°C. The peak run of smolts was about a week later in 1988 in comparison with the previous year.

A forecast of the number of adults expected to return in 1989 was made using the estimate for sea survival of 10.3% based on 1988 results. With an estimate of approximately 60,000-66,000 smolts, 6,180-6,798 salmon are expected to return to the Conne River in 1989, or about 15% fewer than in 1988. Available harvest in Conne River would be 2180-2798 salmon.

Discussion

The forecast of adult returns to the Conne River in 1988 was surprisingly close to the actual total recorded, given that estimates of sea survival and commercial exploitation rates were, for the most part, guessed at for this stock. If it can be assumed that the estimated smolt run in 1987 was reasonably accurate, then a survival of small salmon back to the river of 10.3% is obtained. This is within the range of values that has been reported for other systems and close to the 'guessed' value of about 11%. Our confidence limit for the 1988 smolt is less than ±5% of the estimated population value. Roff (1973) recommends minimum confidence limits of ±10% of the population estimate for mark-recapture estimates. Cousens et al. (1982) indicate that in the International Pacific Salmon Fisheries Commission, a 95% confidence interval of 20% of the estimated value is considered 'good' while an interval of 40% is considered 'average'.

An approximate estimate of combined tag loss, tag mortality, and non-reporting of tags can be obtained with a few assumptions. First, assume that the estimated number of tagged smolts leaving the system is accurate, and second, assume that the estimated total number of smolts migrating out of Conne River is also accurate. With no tag loss or differential tag mortality, the proportion of tag returns to the fence (or food fishery) (N = 41) relative to tagged smolts migrating in 1987 (N = 4863) (P = 0.00843) should be similar to the proportion of small salmon returns (N = 7627) relative to the total estimated smolt run in 1987 (N~74000) (P = 0.10307). In this case the proportion of tagged salmon back to the fence is 91.8% lower than the proportion of untagged salmon returning, implying that the difference may be due to the combined effects stated above.

No streamer tags were returned from commercial fisheries in 1988 and thus no estimates of commercial exploitation were derived. A total of 41 streamer-tagged salmon returned to the counting fence in 1988 (includes one tag recaptured in the native food fishery). [One smolt tagged May 11, 1988 was recovered in the stomach of a Pollock (Pollachius virens) caught June 15, 1988, at Devils Bay, Rencontre West, Newfoundland, approximately 80 km from the Conne River.]

Angling exploitation in 1988, derived from the recreational catch divided by the number of salmon <63 cm released upstream, was 0.217 (1544/7111). This is slightly higher than the value estimated in 1987 (0.181) but lower than the estimate for 1986 (0.275).

The estimated egg deposition of 9.97×10^6 eggs from small salmon is 28% higher than the target egg deposition requirements of 7.8 million eggs. This is equivalent to about 1134 fish <63 cm surplus to the estimated spawning requirements (9.97 - 7.8 million eggs / 2391 x 0.80). An additional 1.68 million eggs were estimated to have been deposited by large salmon (about 878 fish) and are considered as a buffer to the target spawning requirement. It should be noted that the estimated egg deposition from large salmon was derived from an extrapolation of the length-fecundity relationship based on small salmon and may be biased. As pointed out in previous assessments (Dempson et al. 1987), target egg deposition was partially based on habitat and the egg-per-recruit analysis which used an assumed commercial exploitation

rate and similar survival rates from egg to recruit for both stream and lacustrine habitats. Despite the large amount of lacustrine area in the Conne River watershed, no additional information has been derived on the production capacity of this habitat, nor on the commercial exploitation rate.

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Table 1. Opening and closing dates for 1988 Atlantic salmon recreational, commercial, and native food fisheries potentially harvesting salmon of Conne River origin.

Fishery	Season
Recreational	June 18 - September 5
Commercial	June 5 - July 10
Native Food	June 5 - July 31

Table 2. Commercial landings (t) of Atlantic salmon in Statistical Section 36, SFA, 1974-87.

Year	Small	Large	Total	Proportion small
1974	14.2	37.5	51.7	0.28
1975	22.5	24.3	46.8	0.48
1976	20.1	51.8	71.9	0.28
1977	3.3	13.0	16.3	0.20
1978	1.3	3.9	5.2	0.25
1979	3.6	8.7	12.4	0.29
1980	13.2	8.0	21.3	0.62
1981	2.9	8.7	11 7	0.25
1982	9.1	12.4	21.5	0.42
1983	5.5	7.2	12.7	0.43
1984	4.8	6.7	11.5	0.42
1985	14.8	23.9	38.7	0.38
1986	17.6	11.4	29.0	0.61
1987	7.7	8.5	16.3	0.47
Mean				
1977-86	7.6	10.4	18.0	0.39
1982-86	10.4	12.3	22.7	0.45

Table 3. Atlantic salmon landings (in numbers of fish) in the sport fishery 1953-88, and in the native food fishery, 1986-88, for the Conne River.

	Sport fishery				Native food fishery			
	Effort	Salmon				Salmon		
Year	rod days	<63 cm	≥63 cm	Total	Quota	<63 cm	≥63 cm	Total
1953	445	138	26	164				
1954	134	120	23	143				
1955	99	303	37	340				
1956	308	476	36	512				
1957	413	369	23	392				
1958	610	480	55	535				
1959	555	393	18	411				
1960	89	387	0	387				
1961	644	491	0	491				
1962	769	873	11	884				
1963	855	1007	10	1017				
1964	1073	1296	25	1321				
1965	1242	983	39	1022				
1966	1436	879	43	922				
1967	1629	570	3	573				
1968	2379	1724	49	1773	NOTE: Conne River Micmac Indian Band Council reports taking 2,000-3,000 salmon for food each year prior to 1986.			
1969	2909	1751	38	1789				
1970	2909	1673	66	1739				
1971	3483	1707	33	1740				
1972	3194	2509	42	2551				
1973	3427	2139	10	2149				
1974	4033	1988	17	2005				
1975	3800	1903	17	1920				
1976	3894	1931	27	1958				
1977	3375	1665	5	1670				
1978	3122	1735	7	1742				
1979	2147	1010	0	1010				
1980	3512	2238	14	2252				
1981	5029	2691	2	2693				
1982	5268	3302	24	3326				
1983	6972	2192	21	2213				
1984	6709	2343	0	2343				
1985	5202	2729	0	2729				
1986	6038	2060	0	2060	1200	519	3[a]	522
1987	4979	1598	0	1598	1200	18	0	18
1988	5504	1544	0	1544	1200	607	2	609
Mean								
1983-87	5980	2184	-	-				
1978-87	4897	2190	-	-				

[a]Dead in trap.

Table 4. Weekly summary of numbers of Atlantic salmon enumerated at the counting fence on Conne River, Newfoundland, with mean weekly water temperatures (°C) and water levels (cm).

Date	Week	Small			Large			Temperature			Mean water level		
		1986	1987	1988	1986	1987	1988	1986	1987	1988	1986	1987	1988
May 7-13	19							7.5	-	-	32.0	-	-
May 14-20	20	0	0	0	0	2	0	12.3	8.3	-	26.0	44.6	-
May 21-27	21	0	0	0	0	4	0	11.1	11.4	15.6	36.5	28.2	18.6
May 28-Jun 3	22	6	2	0	14	0	0	11.3	13.1	12.0	39.9	15.5	25.2
Jun 4-10	23	108	17	11	42	15	7	12.2	14.1	10.3	61.1	13.0	68.1
Jun 11-17	24	870	1905	652	87	294	123	13.4	14.5	15.1	35.2	32.5	49.8
Jun 18-24	25	2690	3713	1939	160	116	119	15.8	16.1	15.9	24.0	22.3	42.3
Jun 25-Jul 1	26	1899	1514	2256	67	38	114	15.3	16.7	15.1	22.7	17.1	51.9
Jul 2-8	27	612	515	730	7	7	16	15.3	18.8	16.7	33.3	11.3	67.0
Jul 9-15	28	848	1374	769	13	17	5	16.0	22.1	17.8	33.4	3.1	30.4
Jul 16-22	29	263	32	344	4	0	17	17.7	20.8	18.8	30.5	-1.0	16.7
Jul 23-29	30	114	126	91	0	4	3	19.3	20.5	19.3	20.4	-1.6	9.4
Jul 30-Aug 5	31	54	3	268	2	0	11	16.8	20.4	20.2	20.0	-3.0	16.6
Aug 6-12	32	7	25	1	0	1	2	20.1	20.1	20.8	13.4	-7.4	9.3
Aug 13-19	33	2	0	0	0	0	0	19.4	17.2	17.8	9.2	-8.9	3.8
Aug 20-26	34	11	6	57	0	0	1	18.9	18.3	15.6	3.0	-1.6	18.7
Aug 27-Sep 2	35	31	38	0	1	0	0	15.5	16.8	17.6	9.6	-0.5	14.0
Sep 3-9	36	0	417[a]	-	0	0	-	14.8	14.8	-	10.3	-4.3	-
Total/average		7515	9687	7118	397	498	418	16.0	17.8	17.1	26.0	8.5	30.2
Downstream mortalities		21	17	3	1	0	0						
Grand total		7536	9704	7121	398	498	418						

[a]Includes estimate of 400 fish in lower part of the river at the time the counting fence was removed.

Table 5. Summary of biological characteristic information for Atlantic salmon smolt samples from Conne River, Newfoundland, 1986-88

Year	River age	N	Length (mm)			Weight (g)			Age (y)			Sex ratio	
			Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	N	% female
1986	2	2	130	7.1	125-135								
	3	106	152	10.6	125-180								
	4	36	156	10.7	125-185								
	5	1	210										
	Total	145	153	12.0	125-210				3.25	0.48	2-5	-	
1987	2	5	129	24.5	109-163	23.1	12.3	18.8-42.2				4	100
	3	178	144	15.9	106-188	28.3	9.1	11.5-61.8				178	78
	4	83	145	16.9	108-198	30.7	10.6	13.0-73.8				83	76
	5	5	162	16.4	145-184	37.0	14.0	24.6-59.6				5	60
	Total (aged samples)	271	144	16.5	106-198	29.1	9.8	11.5-73.8	3.32	0.54	2-5	270	77
	Total[1]	554	148	17.1	106-209								
1988	2	0											
	3	206	145	14.7	102-191	30.8	9.0	12.4-65.4				205	72
	4	118	151	16.9	113-201	34.5	12.0	15.9-78.8				118	75
	5	4	157	14.9	143-178	40.7	14.0	27.2-60.2				4	50
	Total	328	147	15.7	102-201	32.2	10.4	12.4-78.8	3.38	0.51	3-5	327	73

[1]Some fish were sampled for fork length only.

Table 6. Summary of biological characteristic information for Atlantic salmon virgin one-sea-year grilse samples from Conne River, Newfoundland, 1986-88

Year	River age	N	Length (mm)			Weight (g)			Age (y)			Sex ratio	
			Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	N	% female
1986	2	9	491	30.2	440-540	1367	250.0	900-1700				9	89
	3	212	505	22.3	450-560	1442	199.7	1000-2100				211	76
	4	129	507	23.2	460-570	1471	251.9	1100-2900				129	77
	5	7	517	22.8	490-560	1457	139.7	1300-1600				7	43
	Total	357	506	23.0	440-570	1451	220.4	900-2900	3.38	0.57	2-5	356	78
1987	2	10	495	22.8	470-530	1320	322.5	600-1700				10	60
	3	284	510	22.8	430-580	1511	239.9	1000-2600				250	81
	4	77	509	25.2	450-570	1448	245.3	1000-2000				65	66
	5	1	530			1800						1	100
	Total	372	509	23.4	430-580	1493	245.9	600-2600	3.19	0.46	2-5	326	78
1988	2	8	509	23.0	470-540	1375	249.3	1100-1900				8	88
	3	214	505	26.1	440-600	1344	217.0	1000-2200				210	79
	4	45	510	26.3	470-560	1389	265.6	1000-2000				43	86
	5												
	Total	267	506	26.1	440-600	1352	226.5	1000-2200	3.14	0.42	2-4	261	80

Table 7. Summary of mortalities and removals, and estimated spawning escapement of Atlantic salmon in Conne River, Newfoundland, 1986-88.

	Salmon <63 cm			Salmon >63 cm		
	1986	1987	1988	1986	1987	1988
Upstream migrants						
Fence count	7515	9287	7118	397	498	418
Estimated count		400				
(1)Total migrants	7515	9687	7118	397	498	418
Removals and mortalities						
Known mortalities above counting fence	27	21	7	1	0	0
Unrecorded mortalities - 5% of (1)	376	484	356	20	25	21
Recreational catch	2060	1598	1544	0	0	0
Brood stock	0	245	0	0	10	0
(2)Total removals	2463	2348	1907	21	35	21
Spawning escapement (1) - (2)	5052	7339	5211	376	463	397
Egg deposition	[a]9.20×10^6	13.75×10^6	9.97×10^6	[a]1.41×10^6	1.96×10^6	1.68×10^6

[a]Egg deposition for 1986 has been recalculated using the fecundity-size relationship derived from ripe fish in 1987.

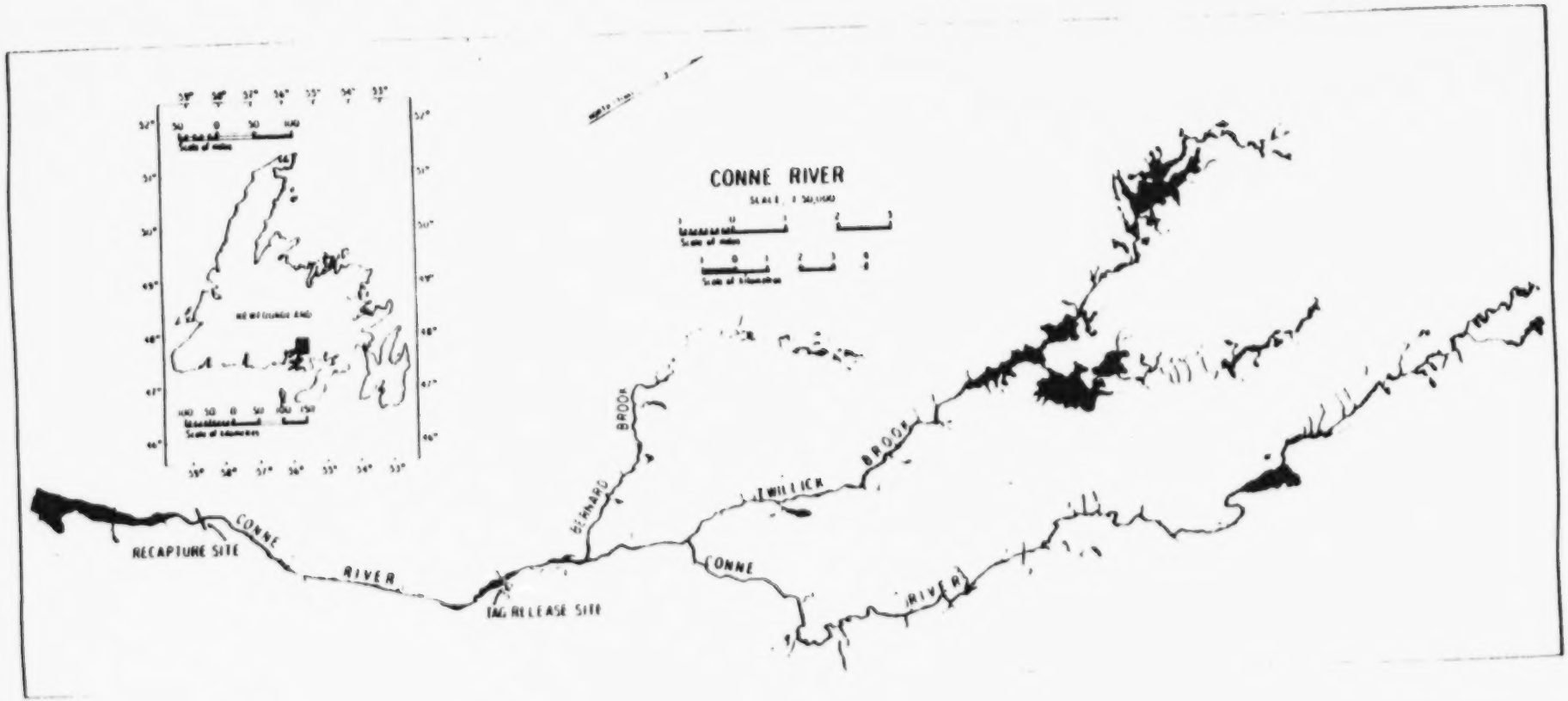

Fig. 1. Conne River, Newfoundland, illustrating the location of the fish counting fences used for tag release and recapture sites in the mark and recapture experiment.

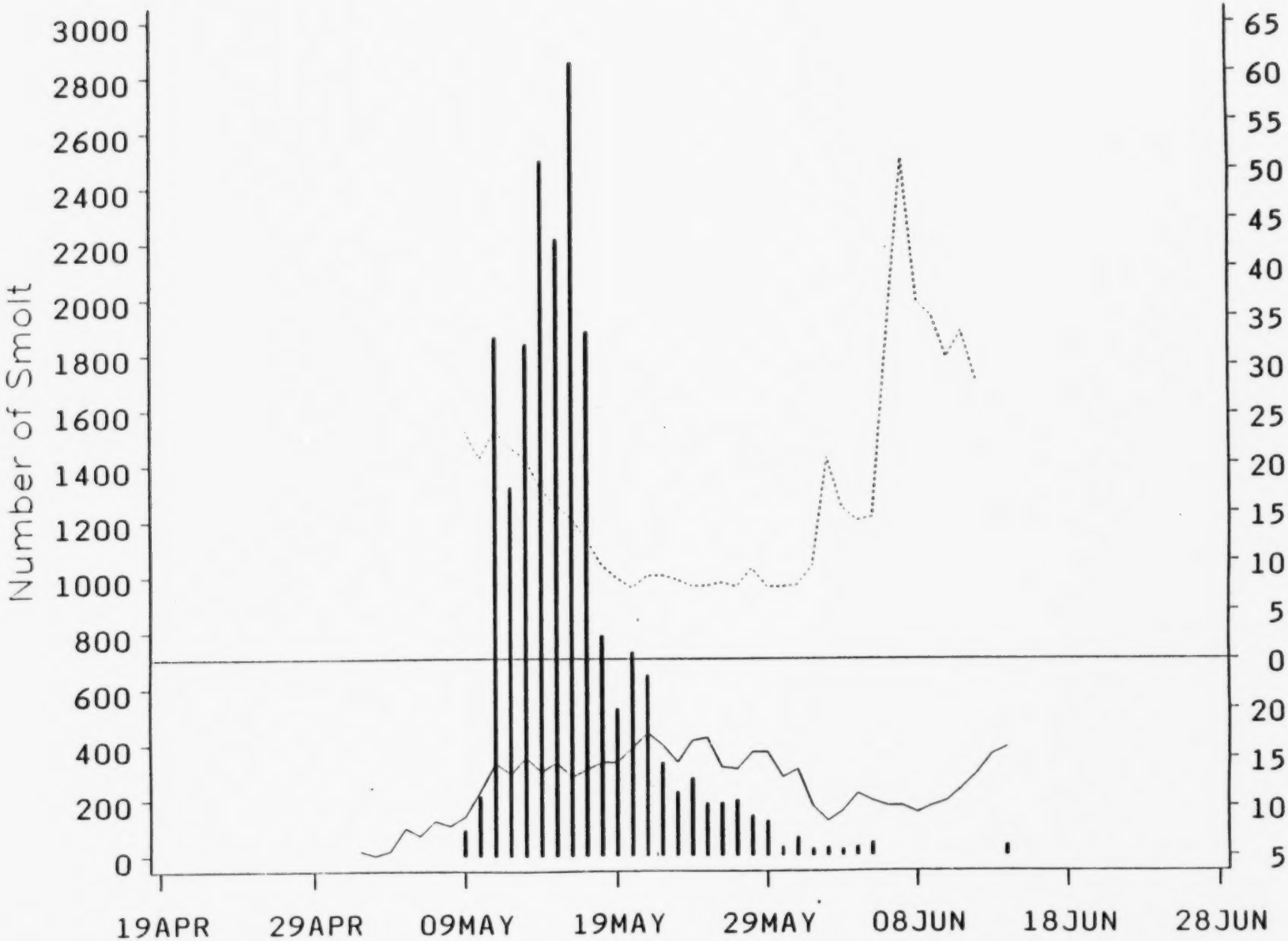

Fig. 2. Number of migrating smolt caught by day at the downstream recapture site in relation to mean daily water temperature and discharge.